Vidyodaya J., Sci., (1991) *Vol.* 3, *No.* 1, pp. 63—69

THE BURYING ABILITY OF O GROUP DOVER SOLE

Solea solea (L.).

J. JINADASA

Dept. of Zoology,
University of Sri Jayewardenepura,
Nugegoda, Sri Lanka

S. M. BAYNES & B. R. HOWELL,
Fisheries Laboratory, Benarth Road, Conwy,
Gwynedd, LL32 8UB, UK.

Abstracts

The particle size of a substrate determines the ability of 0 *group Dover sole Solea solea* (*L.*) *to bury for concealment. The larger the fish, however, the larger the particle size in which they are able to bury. When presented with a choice of a range of particle sizes,* 95-120*mm fish are more likely to be found in sediment of* 1-2*mm grain size, than in anything finer. Fish of* 18-40*mm were never found in sediment of a particle size larger than* 0.35 - 0.50*mm.*

Key words: Burying ability, Dover sole

1. Introduction

Dover sole, *Solea solea* (L.), remain in the water column during their yolk sac and larval stages (Fluchter, 1965) and begin to settle on the bottom at the start of metamorphosis. Soon after the completion of metamorphosis the fish begin to feed at the bottom and conceal themselves by digging into the substrate when not active (Rosenthal, 1966). Their ability to bury and obtain camouflage is likely to be affected by the type of substrate.

Young sole are normally caught in areas of fine sand and mud (Todd, 1903). Sand particles of 0.1 - 0. 7mm diameter are common in the gut of O-group sole caught on coastal nursery grounds (Rogers and Jinadasa, 1988) and are probably typical of the substrate of these feeding areas. The food of 0-group sole consist mainly of bivalve siphons, polychaete worms and harpacticoid copepods, which are mostly found in areas of soft sand (De Groot, 1971; Todd, 1903). Physical characteristics of the substrate, such as grain size, influence the fauna and so affect its suitability as a habitat for sole. There is, however, little published information on the extent to which substrate grain size directly affects the distribution of small sole through its influence on their ability to bury. The purpose of the present study was to evaluate the effect of grain size on the burying behaviour of 0-group sole of various sizes.

2. Materials and Methods

The bottom of a 300 litre fibre-glass aquarium was partitioned into six equal compartments (350 x 300 x 50mm). These compartments were randomly selected and filled with 0. 15, 0.25, 0.35, 0.50 and 1.0mm diameter washed

sand obtained from a local beach. The particle size was defined as that retained on a mesh of the particular size, having passed through the next larger size. One compartment was kept empty to record settlement of the fish in the absence of sediment. The aquarium was continuously supplied with filtered sea water at 200 ml min^{-1}. The depth of the water column above the substrate was maintained at 25cm and the water was aerated at two points. Artificial white light was provided to supplement daylight, during the natural photoperiod. The temperature and salinity were recorded daily.

Eight experiments were carried out from January to April 1988. In the first, forty five 0-group sole, ranging in length (total) from about 18 to 40mm and in weight from about 0.1 to 0.7g, were stocked in the aquarium. The fish were fed minced fresh mussel which was evenly distributed to all the compartments daily between 16.00h & 17.00h. The fish were allowed to acclimate for three days before observations were made. The number of fish buried in and resting on the substrate were recorded each morning. The number of fish resting on the walls of the compartments was also recorded; all fish were accounted for. The same group of fish was used throughout the three week period of the experiment.

The procedure was repeated with three other batches of fifteen fish of different size ranges.,Their lengths were 45-60, 65-90, 95-125mm and weights 0.5-1.4, 4.1-7. 7, and 7.4-18.2g respectively. The substrate grain sizes used in experiments with these larger fish were 0.35, 1.0, 2.0, 4.0, and 8.0mm (<16mm) diameter, with a control. Each experiment was continued for about twenty days.

A second series of experiments was carried out in five 10 litre aquarta with running sea water. Each contained a different substrate type covering the range of sizes used in the experiments which compared them all in single aquaria. Five fish of the 18-40mm size range were placed in each aquarium and the number of fish buried in each of the substrates was recorded daily for five weeks. The experiment was repeated for the other three size groups of fish.

The statistical significance of comparisons between the numbers of fish buried in or on the different substrates was assessed using "Student's" t test.

3. Results

During the period of the experiments the temperature of the water in the aquarium ranged from about 9.5 to about 17.5°C and salinity from about 26°/$_{oo}$S to about 32.;0°/$_{oo}$S (Tables I & II).

The group of smallest fish (18-40mm) was mostly found buried in the 0.15 to 0.35mm substrate. There was a significantly higher number in 0.25mm substrate than in the 0.35mm substrate, but with no signiacant difference between 0.15mm and 0.25mm substrate. Of the fish resting on the surface, however, there were significantly more on the 0.50mm substrate than on others (Table I & Fig. 1 and 2).

TABLE I : The mean number of fish buried in or resting on each substrate (all types of substrate in one aquarium)

Length group (mm)	No. of fish	Temp. range (C)	Salinity range (o/ooS)	Substrate particle size (mm)								
				None	0.15	0.25	0.35	0.50	1.0	2.0	4.0	8.0
18-40	45	15.0-17.5	26-32	4.2	3.0 (6.3)	2.1 (6.3)	1.4 (4.2)	5.1 (0.05)	3.5 (0)			
45-60	15	8.-012.0	28-32	1.1			0.5 (6.0)		1.5 (0.2)	0.55 (0)	0.6 (0)	0.05 (0)
65-90	16	11.0.15.0	28-33	1.7			0.09 (5.0)		0.6 (3.2)	0.1 (0.9)	1.1 (0)	0.43 (0)
95-125	15	13.5-16.0	27-32	.56			0.13 (3.8)		0.25 (5.1)	1.0 (1.6)	0.25 (0)	0.06 (0)

The figures in parenthesis ( ) deoote the number of fish buried in the substrate, the open figures those resting on the substrate.

TABLE II : The mean number of fish buried in or resting on each substrate (different substrates in separate aquaria)

Length group (mm)	No. of fish	Temp. range (C)	Szlinity range (o/ooS)	Substrate particle size (mm)								
				None	0.15	0.25	0.35	050.	1.0	2.0	4.0	8.0
18-40	6	15.0-17.5	26-32	6	1.9 (4.6)	1.8 (3.5)	2.5 (2.6)	4.0 (0.2)	4.1 (0)			
45-60	6	8.0-12.0	28-32	5.1			1.0 (4.4)		2.7 (0.8)	3.1 (0)	0.6 (0)	2.6 (0)
65-90	6	11.0-15.0	28-33	5.2			1.8 (4.3)		2.1 (2.8)	4.1 (0)	1.1 (0)	3.1 (0)
95-125	6	13.0-16.0	27-32	5.2			1.1 (3.8)		0.06 (4.9)	0 (0)	0.25 (0)	4.0 (0)

The figures in parenthesis ( ) denote the number of fish buried in the substrate, the open figures those resting on the substrate.

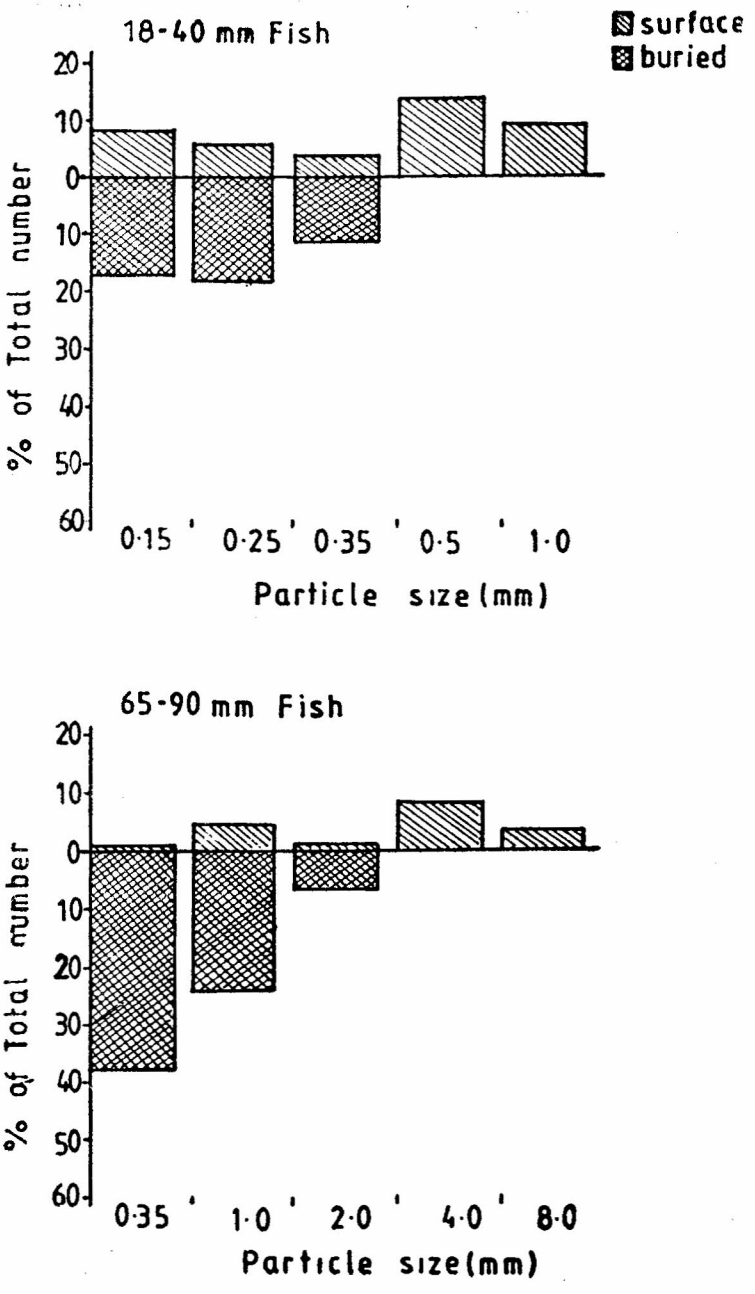

Fig. 1 Percentage of the total number of different sizes used in the substrate choice experiment which were either buried or resting on the surface of the substract

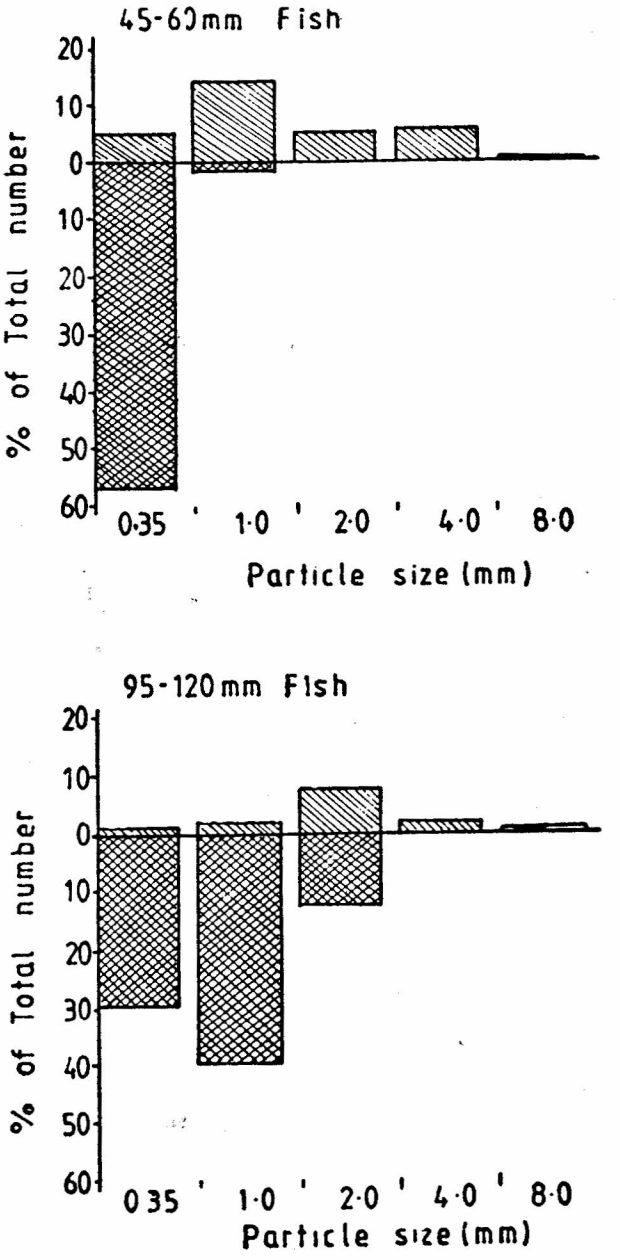

Fig. 2. Percentage of the total number of fish of different sizes used in the substrate choice experiments which were either buried or resting on the surface of the substrate.

The substrate particle size refers to the mesh size which retained particles that had passed through the next larger size of mesh. Those particles in the 8mm grade ranged up to approximately 16mm.

In contrast, of the two intermediate size groups (45-60 mm & 65-90mm), more buried in the 0.35mm substrate than in any of the other substrates offered. The largest fish (95-125mm) showed a preference for the 1.0mm substrate. Fishes of these size ranges were found almost equally distributed on the substrates when they were not buried (Table I & Fig. 1 and 2).

Whenever the fish were given only one type of substrate at a time similar results were obtained as when they were given a choice. The smallest fish never buried in a substrate larger than 0.50mm and the largest fish never in substrate larger than 1.0mm. On any other size range, they were found resting on the substrate (Table II).

4. Discussion

For concealment sole bury in the substrate by a series of movements until the whole body is covered by sand. The grain size of the substrate must be below a size and density which a fish is able to move if it is to feed or bury. If the particles are too large the fish remains on the surface of the substrate. The size range of fish examined in these experiments, with a selection of different substrates, demonstrated that as fish grow they are able to bury in substrate with larger particles. For the smallest fish tested (18-40mm) the maximum particle size was 0.25-0.35mm, but for the largest fish (95-125 mm) this particle size was no more than 2.0mm diameter and 1.0mm was preferred. It is very likely that the availability of sediments of the smallest particle size will limit the distribution of newly metamorphosed and young juvenile fish.

All species of flat fish are demersal and they feed primarily on benthos (De Groot, 1971). The prey species are largely confined to the soft, sandy mud bottom of the sea. When the fish search for food they disturb substrate with their head and fin rays in order to find prey. Sole feed by moving on to the food using primarily chemical and perhaps visual clues (De Groot, 1971. At the same time as the fish are searching for food, their upper side may be partly covered with a layer of sand, so that the skin cannot be seen (Bateson, 1989). Thus their ability to cover themselves with sand whilst feeding may be important in reducing their conspicuousness to predators.

The availability of food in the substrate was not a factor in this series of experiments, but it is clear that, as well as substrate particle size, this will restrict the distribution of 0 group sole in the wild.

5. Acknowledgement

The authors are thankful to the Association of Commonwealth Universities for the Fellowship offered to the senior author ro remain in the UK to carry out the research, which formed a part of his research programme on pond culture of Dover Sole *Solea solea* (L). The guidance given by Professor Stephen J. Lockwood, Director, Fisheries Laboratory, Conwy, UK, is also thankfully acknowledged.

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